IN THE UNITED STATES PATENT & TRADEMARK OFFICE

Application Number	:	(unassigned)
Applicant	:	Peter T. Gibb et al.
Filed	:	August 26, 2003
Tech Cntr/AU	:	(unassigned)
Examiner	:	(unassigned)
Entitled	:	Refrigerator Lubricant Compositions

Attorney Reference	:	090128-0305379
Customer Number	:	00909

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SUBMISSION OF PRIORITY DOCUMENT

Attached please find the certified copy of the foreign application from which priority is claimed for this case:

Country	Application Number	Filing Date
United Kingdom	0105065.7	1 March 2001

Date: August 26, 2003

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1	Your reference	UQI 50949
2	Patent application number *(The Patent Office will fill in this part)*	**0105065.7**
3	Full name, address and postcode of the or of each applicant (*underline all surnames*)	Imperial Chemical Industries PLC Imperial Chemical House Millbank, London SW1P 3JF
	Patents ADP Number (*if you know it*)	935003
	If the applicant is a corporate body, give the country/state of its incorporation	United Kingdom
4	Title of the invention	Lubricant Compositions
5	Name of Your Agent (*if you have one*)	GRAHAM, John George
	"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*	Uniqema Intellectual Property PO Box 90, Wilton Middlesbrough Cleveland England, TS90 8JE
	Patents ADP Number (*if you know it*)	07896889001

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11 I/We request the grant of a patent on the basis of this application

Signature John G Graham

Date 1 March 2001

12 Name and daytime telephone number of person to contact in the United Kingdom: John George GRAHAM (01642) 432721

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Lubricant Compositions

The invention relates to lubricant compositions for refrigerant applications, especially lubricant compositions for use in rotary vane compressors used in refrigeration equipment, and to compressors, especially rotary vane compressors, lubricated by such compositions.

Refrigeration systems consist of a compressor for compressing a refrigerant gas, a condenser for condensing the compressed gas, an expansion device and an evaporator section in which the condensed gas is evaporated to provide a cooling effect, the evaporator section being connected by a return line to the compressor. The compressor, in having moving parts, requires lubrication to reduce friction and wear and to provide, in some designs, a sealing effect.

Historically, lubricant compositions used in refrigeration systems contained, as a base oil, mineral oils, alkylbenzenes, paraffinic oils, naphthalenic oils and polyα olefins (PAOs), the refrigerant typically being chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs). However, following the Montreal Protocol, in 1987, owing to the ozone-depletion properties of such refrigerants, CFCs, and subsequently HCFCs, were to be phased out.

The introduction of alternative refrigerants introduced included fluorocarbons (FCs) and hydrofluorocarbons (HFCs). However, traditional refrigerant lubricant compositions such as mineral oils and alkylbenzenes, owing to their immiscibility with the new refrigerants, were not considered to be adequate for these applications. For example, such traditional lubricants suffer from oil return problems and create high torque in the motor at start-up owing to their high viscosity when cold. Lubricant compositions considered suitable for use with the new refrigerants, owing to their higher polarity and hence greater miscibility with the new refrigerants, included polyol esters (POEs), polyvinylethers (PVEs) and polyalkyleneglycols (PAGs).

However, the high loads generated by the fixed vane on the compression element in rotary vane compressors used in refrigeration applications create a difficult environment for compressors containing such lubricant compositions to operate in. Typically, some lubricant compositions do not perform adequately leading to significant wear of the vane and the compression element in the compressor. For example, POEs, owing to their solubility in the refrigerant and low viscosity pressure coefficient are not able to maintain sufficient viscosity under operating conditions to prevent metal to metal contact and wear. Additionally, owing to the heat generated at the tip of the vane, some lubricant compositions can break down into undesirable decomposition products, for example POEs can degrade to acids, which can lead to corrosion and other deleterious affects.

Attempts have been made to overcome these problems.

For example, in EP 0533957, a rotary compressor used in a refrigeration system containing 1,1,1,2-tetrafluoroethane (R134a), an HFC, and a lubricant composition consisting of a POE, the vane is made of a material having a hardness and melting point higher than the material from which the compression element is made.

A similar compressor is disclosed in US 5966949. However, in that instance, the POE lubricant composition also contains an extreme pressure additive such as phosphoric acid triester.

PVEs have found particular utility in rotary vane compressors but are expensive relative to other lubricant compositions.

More generally, attempts have been made to use the traditional lubricant compositions including mineral oil, alkylbenzenes etc with the new refrigerant gases.

For example, in EP 0622445, it is proposed to use a mixture of fluorine-containing refrigerant gases at least one of which is inflammable, the mixture being non-flammable, in combination with a lubricant composition which, under the working conditions of the refrigeration system, has a solubility in the refrigerant gas mixture of 0.5 to 7% by weight. The refrigerant gas mixture is selected from HFCs,fluoroamine, fluoroether, fluoropropane, fluoroethane and fluorosilane. The lubricant composition may be selected from a chlorofluorocarbon polymer, a perfluorocarbon polymer, perfluoroalkylpolyether, a modified silicone or a chlorinated aromatic compound or from alkylbenzenes, poly α olefins, paraffinic oils, naphthalenic oils, polyphenylene ethers, polyphenylenethioethers and chlorinated paraffins.

In EP 1018538, it is proposed to use hydrocarbon oil as the base oil for the lubricant composition with a refrigerant that contains hydrocarbon. Possible refrigerants include *inter alia* methane, ethylene, ethane, propylene, propane, butane either alone or in mixtures with one another or with an HFC. Possible lubricant compositions contain a base oil of naphthalenic mineral oils, paraffinic mineral oils, olefin polymers, naphthalene compounds, alkylbenzenes and mixtures thereof.

However, owing to the low solubility of such traditional lubricant compositions in HFCs, there still remain issues of oil return from the refrigeration system and start-up problems owing to the high viscosity of such compositions at relatively low temperatures.

It is an object of the present invention to provide a lubricant composition that reduces or obviates one or more of the aforementioned disadvantages.

According to the present invention, a lubricant composition for use in a rotary vane compressor has a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

In particular, the base oil component of the lubricant composition comprises at least 55% by weight of alkylbenzene and at most 45% by weight of a polyol ester; more preferably between 55% and 75% by weight of alkylbenzene and between 45% and 25% by weight of polyol ester. More especially, the base oil component of the lubricant composition consists essentially of alkylbenzene and polyol ester.

Alkylbenzenes and polyol esters and their preparation are described in Synthetic Lubricants and High-Performance Functional Fluids (1st Edition Edited by Ronald L Shubkin, 1993, ISBN 0-8247-8715-3; 2nd Edition Edited by Leslie R Rudnick and Ronald L Shubkin, 1999, 0-8247-0194-1). Particular reference is made to Part I, Sections 2 and 5 and Part II, Section19 of the 1st Edition and to Part I, Sections 3 and 7 and Part II, Sections 24 and 25 of the 2nd Edition.

Alkylbenzenes particularly suitable for use in the invention include mono-alkylbenzenes, di-alkylbenzenes, di-phenylalkanes and mixtures thereof. Preferably, the alkyl component of the alkylbenzene is branched and is derived from propylene oligomers.

Preferred alkylbenzenes for use in the invention have a molecular distribution in which at least 80%, and more especially, 100% of the molecular weight fraction is greater than 200; more particularly, at least 75% of the molecular weight fraction is greater than 300; and especially at least 40%, more particularly 50%, of the molecular weight fraction is greater than 350. Preferably, at least 90% of the molecular weight fraction is below 500, more especially below 450.

Preferred alkylbenzenes have a kinematic viscosity of at least 10 cSt, and more preferably at least 25 cSt, but not more than 70 cSt at 40°C and a kinematic viscosity of at least 2 cSt, and more preferably at least 3.5 cSt, but not more than 10 cSt at 100°C.

Preferred alkylbenzenes have a pour point of less than -10°C more preferably less than -20°C and particularly less than -30°C.

Preferred alkylbenzenes have an acid number of less than 0.04 mgKOH/g.

Polyol esters particularly suitable for use in the invention are made from polyhydric alcohols and monobasic carboxylic acids. Particularly preferred polyol esters are made from one or more alcohols selected from neopentylglycol (NPG), trimethylolpropane (TMP) and pentaerythritol (PE) and dimers and trimers thereof and one or more acids selected from linear and/or branched C_5 to C_{18} acids, particularly C_5 to C_{13} acids and more particularly C_5 to C_9 acids.

Preferred polyol esters have a kinematic viscosity of at least 5 cSt but not more than 40 cSt and more preferably less than 25 cSt at 40°C and a kinematic viscosity of at least 1.5 cSt but not more than 5 cSt and more preferably less than 4 cSt, at 100°C.

Preferred polyol esters have a pour point of less than -40°C more preferably less than -50°C and particularly less than -55°C.

Preferred polyol esters have an acid number of less than 0.04 mgKOH/g.

Preferred lubricant compositions according to the invention have a kinematic viscosity of at least 5 cSt but not more than 40 cSt and more preferably less than 25 cSt at 40°C and a kinematic viscosity of at least 2 cSt but not more than 6 cSt and more preferably less than 5 cSt, at 100°C.

Lubricant compositions according to the invention also comprise one or more other lubricant additives of known functionality at levels between 0.0001 and 20 %, more preferably between 0.01 and 10% more especially between 0.01 and 5%. Suitable additives include antioxidants, antiwear additives, extreme pressure agents, acid scavengers, foaming agents, anti-foaming agents, stabilisers, surfactants, viscosity index improvers, corrosion inhibitors, metal deactivators or passivators, lubricity improvers or oiliness agents and friction modifiers.

According to another aspect of the invention, the use in a rotary vane compressor of a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

According to yet another aspect of the invention, a method of lubricating a rotary vane compressor comprises utilising a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

According to a further aspect of the invention, a fixed-vane rotary compressor charged with a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

According to a still further aspect of the invention, a refrigeration system comprising a fixed-vane rotary compressor, said system being charged with a refrigerant comprising a chlorine-free, fluorine-containing heat transfer fluid and a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

Preferably the refrigerant is a hydrofluorocarbon and more preferably is selected from the group comprising difluoromethane (R-32), trifluoromethane (R-23), 1,1,2,2-tetrafluoroethane (R-134), 1,1,1,2-tetrafluoroethane (R-134a), 1,1,1-trifluoroethane (R-143a), 1,1-difluoroethane (R-152a) pentafluoroethane (R-125) and hexafluoroethane (R-116) and mixtures of two or more thereof. Particularly useful refrigerants are R-32, R-116, R125, R134a, R-143a and mixtures thereof.

Lubricant compositions according to the invention provide good lubrication, oil return and low start-up torque conditions at a relatively low cost as compared to the lubricant compositions used hitherto.

The invention will now be described further by way of example only with reference to the accompanying drawings and the following Examples.

In the drawings:-

Figure 1 shows a simplified exploded perspective view of a fixed-vane rotary compressor; and

Figure 2 is a graphical representation of the results obtained in Example 7.

Referring to Figure 1, the fixed-vane rotary compressor 10 has a cylindrical housing 12 in which is concentrically mounted a shaft 14 for rotation about an axis concentric with the housing 12. The shaft 14 has mounted between seals 16 a cam member 18. A cylindrical compression member 20 is located around the cam member 18 so that the shaft 14 through the cam member 18 rotates it. A fixed vane 22 is mounted in the periphery of the housing 12 and is resiliently biased to an inner position in which it protrudes into the housing. The vane 22, at its tip 24, engages with the outer surface of the compression member 20.

In operation, the rotation of the compression member 20 eccentrically within the housing 12 by the cam member 18 causes the vane 22 to move radially of the housing 12. Fluid entering the housing 12 through an inlet (not shown) is compressed between the vane 22 and the compression member 20 by rotation of the compression member 20. The compressed fluid passes through a valved or throttled outlet (not shown) in the housing adjacent the vane 22 immediately upstream of it relative to the direction of rotation of the compression member 20.

A lubricant composition is present in the compressor 10 to lubricate the tip 24 of the vane 22 as it contacts the outer surface of the compression member 20 and to lubricate the sides of vane 22 that are in sliding contact with the housing 12. The lubricant composition also provides a satisfactory seal between the high- and low-pressure sides of the tip 24 of the vane 22 and the compression member 20.

Example 1

The components of samples used for evaluation are set out in Table 1 and the samples used for evaluation are set out in Table 2.

Table 1

No	
1	Is an alkylbenzene available from Chevron Company under the trade name Zerol 55.
2	Is an alkylbenzene available from Chevron Company under the trade name Zerol 150.
3	Is an alkylbenzene containing a phosphate antiwear additive that used in fixed-vane rotary compressors in combination with R22 (an HCFC) refrigerant.
4	Is a polyol ester made by reacting PE with linear C_5 monocarboxylic acid.
5	Is a polyol ester made by reacting NPG with linear C7 acid (NPG nC7).
6	Is a polyol ester made by reacting a 50:50 mixture of PE and di-PE with linear C5, linear C7 and branched C9 acids (25:25:50).
7	Is a polyol ester available from Japan Energy Corporation that is used in fixed-vane rotary compressors in combination with HFC refrigerants.
8	Is a PVE available from Idemitsu Kosan that is used in fixed-vane rotary compressors in combination with HFC refrigerants.

Table 2

No	Alkylbenzene	POE	PVE	Additives	
9	31.5% No 1 and 58.5% No 2	10% No 4			0.05% BHT
10	90% No 2	10% No 4			0.05% BHT
11	70% No 2	30% No 5			0.05% BHT
12	70% No 2	30% No 5		3% TCP	0.05% BHT
13	65% No 2	35% No 5		3% TCP	0.05% BHT
14*		100% No 6		6% TCP	0.1% BHT
15*	100% No 2				
16*	100% No 3				
17*		100% No 7			
18*			100% No 8		

* Denotes comparative samples.

Where:-

BHT is 3,5-dibutyl-4-hydroxytoluene, an antioxidant; and
TCP is tricresyl phosphate, an antiwear additive.

Additionally, the base oil component is expressed in wt% of that component and the additives are expressed in wt% of the total composition.

The properties of the samples are given in Tables 3 and 4.

Table 3

Property	T st Method	Sample No						
		1	2	3	4	5	6	8
Viscosity (cSt) 40°C 100°C	ASTM D-445	5.7 1.7	33.5 4.4	48.2	15.2 3.6	5.6 1.9	72 9.8	67.8 8.4
Viscosity Index	ASTM D-2270		25		121	167	120	91
Pour Point (°C)	ASTM D-97		-40		-55	<-60	-39	
Flash Point COC (°C)	ASTM D-92		170		228	184	270	
Density at 20°C (g/mL)	ASTM D-1298		0.87		1.02	0.93	0.98	
Acid Value (mgKOH/g)	ASTM D-974	0.02	0.02	0.01	0.02	0.01	0.02	0.01
Water Content (ppm)	ASTM D-1064	<40			<40	<40	<40	
Colour (ASTM)	ASTM D-1209	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Low Temperature Mis-cibility (°C) 10% Lubricant in R-12 10% Lubricant in R-22 10% Lubricant in R-134a 10% Lubricant in R-404A 10% Lubricant in R-407C	In House		<-73 -72			-56		
4 Ball Wear Scar (mm) 40kg, 1 hour	ASTM D-2783							0.99
Falex Load to Fail (lb)	ASTM D-3233							1800

Table 4

Property	Test Method	Sample No				
		9	10	11	12	13
Viscosity (cSt) 40°C 100°C	ASTM D-445	14.5 2.9	27.4 4.3	15.4 3.2	15.5 3.24	14.1 3.1
Viscosity Index	ASTM D-2270	11	16	55	55	53
Pour Point (°C)	ASTM D-97	-42		-55	-57	
Flash Point COC (°C)	ASTM D-92	164			179	
Density at 20°C (g/mL)	ASTM D-1298				0.892	0.894
Acid Value (mgKOH/g)	ASTM D-974	0.02	0.01	0.02	0.03	0.02
Water Content (ppm)	ASTM D-1064	<40	<40	<40	<40	<40
Colour (ASTM)	ASTM D-1209	<0.5	1-1.5	1-1.5	1-1.5	1-1.5
Low Temperature Miscibility (°C) 10% Lubricant in R-12 10% Lubricant in R-22 10% Lubricant in R-134a 10% Lubricant in R-404A 10% Lubricant in R-407C	In House*2		IM*1 IM*1 IM*1	IM*1 IM*1 IM*1	IM*1 IM*1 IM*1	
4 Ball Wear Scar (mm) 40kg, 1 hour	ASTM D-2783				0.64	
Falex Load to Fail (lb)	ASTM D-3233				1900	
Falex (Wear Teeth) 5 hours, 400lb, steel/steel in R-134a	ASTM D-1209				17	

IM^{*2} = Immiscible.

*1 The low temperature miscibility of each of the samples is determined by placing an accurately weighed portion of the Sample (approximately 0.6g) into a sight glass, connecting the sight glass to a vacuum pump to evacuate it, cooling the sight glass using an acetone/drikold mixture and adding an accurately weighed portion of refrigerant (approximately 5.4g). The portions of Sample and refrigerant equate to 10% lubricant in refrigerant. The sight glass and its contents are then allowed to reach room temperature. If, upon examination of the contents of the sight glass, two or more phases are present, then the lubricant is immiscible with the refrigerant at room temperature and this fact is reported. If, upon examination of the contents of the sight glass, one phase is present, then the sight glass and its contents are cooled at a rate of approximately 1°C/5 minutes until the mixture goes cloudy, ie phase separation is beginning, and the cloud point temperature is reported.

An alkylbenzene is a polymeric compound, having a distribution of molecular weights that can be characterised in a number of different ways. One such characterisation is number-average molecular weight (Mn). This is a normal counting type of molecular weight. Another way is the weight-average molecular weight (Mw), which enhances the higher end of the molecular weight distribution.

For Sample 2, ie Zerol 150, the Mn and Mw are given below:

Mw = 379
Mn = 362.

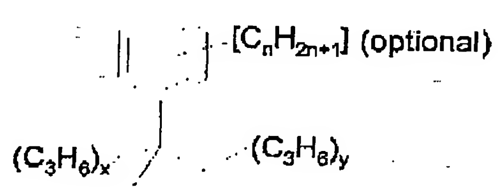
In this case Mn and Mw are very close in value, indicating that Sample 2 has a very narrow molecular weight distribution.

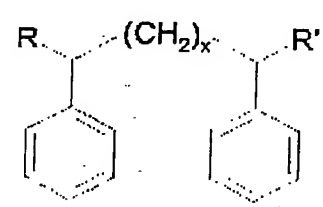
The molecular distributions of Samples 1 and 2 are as shown in Table 5.

Table 5

Sample No	MW <200	MW 200-300	MW 301-350	MW >350
1	13	80	6	1
2	<0.5	17	23	60

Samples 1 and 1 (Zerol 55 and Zerol 150, respectively) are branched alkylbenzenes, the chemical structure of which is likely to consist of the following molecular types.





Sample 3 is a branched alkylbenzene that is likely to have a similar structure to Samples 1 and 2.

Example 2

Bench wear testing of Samples 13 and 16 to 18 has been performed according to ASTM standard D-4172 (four-ball method). The four-ball method consists of a rotating steel ball pressed against three other steel balls and is quantified by measurement of the diameter of the wear scar produced. The conditions of the test are 40kg load for 1 hour, under an atmosphere of air. The diameter of the wear scar on the balls is a direct measure of the amount of wear. The smaller the wear scar, the better the lubricant at preventing wear under these conditions.

The results of the test are shown in Table 6.

Table 6

Sample No	13	16	17	18
Wear Scar (mm)	0.642	1.77	1.047	0.605

This data demonstrates that the wear performance under these test conditions is comparable for Samples 13 (in accordance with the invention) and 18, both of which demonstrate significantly better wear than Samples 16 and 17.

Example 3

Three types of miscibility behaviour may be observed, namely:

a) miscible at the lowest temperature in the system;
b) not miscible at some points but still soluble at all points in the system (partially miscible); and
c) not miscible and not soluble at all points.

Sample 13 was measured to be immiscible at concentrations of at least 5% with HFC refrigerants at all temperatures below room temperature (21°C). This will not significantly affect the performance provided either the lubricant composition is miscible at concentrations of around 2% (representative of the concentration of lubricant composition circulating in a refrigeration system) or there is sufficient solubility to enable oil return to the compressor.

Example 4

Materials compatibility data was measured according to ASHRAE 97 sealed tube method. The test lubricant compositions were placed in autoclaves with samples of polyethylene terephthalate (PET – commonly used as an insulating material in electrical motors), polybutyl terephthalate (PBT – typically found in compressors), steel, aluminium and copper. The autoclaves were then sealed and evacuated to allow the addition of R-134a refrigerant. The proportion of refrigerant to lubricant composition is 50:50. The test conditions were 14 days at 130°C and 400psig pressure.

Lubricant composition analysis before and after the tests is shown in Table 7.

It can be observed that there is very little change in the condition of the lubricant compositions under these conditions, with the exception of the marked reduction in viscosity of Sample 17. There was no significant change in the condition of the test materials during this test.

Table 7

Sample No	Viscosity (cPs)		Acid Value (mgKOH/g)		Colour (ASTM)	
	Before	After	Before	After	Before	After
13	12.4	12.6	0.02	0.01	1-1.5	1-1.5
16	50.9	51.9	0.01	0.01	<0.5	<0.5
17	65.2	56.2	0.01	0.01	<0.5	<0.5
18	65.2	62.4	0.01	0.01	<0.5	<0.5

Example 5

Thermal stability data was measured according to ASHRAE 97 sealed tube method. The test lubricant compositions were placed in autoclaves, which were sealed and evacuated to allow the addition of R-134a refrigerant. The proportion of refrigerant to lubricant composition is 50:50. The test conditions were 14 days at 175°C and 600psig pressure.

Analysis of the lubricant compositions before and after the tests is shown Table 8.

Table 8

Sample No	Viscosity (cPs)		Acid Value (mgKOH/g)		Colour (ASTM)	
	Before	After	Before	After	Before	After
13	12.4	13.0	0.02	0.02	1-1.5	1-1.5
16	50.9	48.1	0.01	0.01	<0.5	<0.5
17	65.2	65.0	0.01	0.01	<0.5	<0.5
18	65.2	58.7	0.01	0.01	<0.5	<0.5

Again, it can be observed that there is very little change in the condition of the lubricant compositions during this test, apart from a marked reduction in viscosity of Sample 18. This might be due to deterioration of the lubricant composition of Sample 18 under the higher temperature conditions of this test compared to the materials compatibility test in Example 4.

Example 6

In an alternative test, samples of the lubricant compositions were heated in a glass vessel at 120°C for 7 days under a stream of dry nitrogen. The condition of the lubricant compositions was measured before and after the test. The results are given in Table 9.

The only significant result from this test is the increase in acid value observed with Samples 17 and 18. The Samples 13 and 16 show physical properties virtually unchanged from the virgin lubricant compositions.

Table 9

Analysis Before Testing				
Sample No	Moisture (ppm)	Viscosity @ 40°C (cSt)	Acid Value (mgKOH/g)	Colour (Hazen)
13	17	14.0	0.017	346
16	0	55.1	0.006	86
17	3	66.5	0.003	44
18	24	69.3	0.011	13
Analysis After Testing				
13	38	14.0	0.009	394
16	20	55.1	0.006	127
17	20	66.3	0.008	57
18	61	69.6	0.025	73

Example 7

Hygroscopicity (the uptake of moisture from the atmosphere) is important because the lubricant compositions will be handled in air for short periods of time and therefore have the ability to increase in moisture content above the levels at which they are commonly supplied. Many air-conditioning system manufacturers are preferring to omit the in-line drier, which acts as an 'insurance' against moisture ingress, due to cost considerations. The presence of levels above 100ppm in a refrigeration or air-conditioning system is considered detrimental to reliability due to possible interactions with the PET motor wire-winding insulation leading to degradation and motor failure. Therefore, the less a lubricant composition absorbs moisture from the atmosphere, the less likely a level of moisture is reached in the system that may lead to these potential failures.

To measure the hygroscopicity of the lubricants the following technique was used. The samples were dried using a dry nitrogen sparge and the initial moisture recorded. The dry lubricant was filled into a 100ml wide-necked bottle, which was placed into a desiccator containing a saturated sodium chloride solution. The desiccator was sealed and left at room temperature (21°C). Moisture readings on the lubricant samples were taken every 30 minutes for the first 3 hours and then every hour until 6 hours had elapsed.

Each moisture result is an average of three readings. The results are shown in Table 10.

The results of this test have been plotted and are shown in Figure 2.

Example 8

Lubricant compositions were evaluated by charging a fixed-vane rotary compressor with the relevant sample and appropriate refrigerant gas connected in line with other components of a refrigeration system.

The test conditions are shown in Table 11.

The compressor is operated at these conditions for 2000 hours and then stripped down for analysis of the wear on metal components.

Table 10

Time (mins)	Moisture Content (ppm)			
	Sample 13	Sample 16	Sample 17	Sample 18
0	0	0	0	0
30	6	0	0	21
60	32	0	8	105
90	36	0	6	55
120	45	0	24	89
150	47	0	22	148
180	38	0	33	173
240	57	0	70	252
300	53	0	52	291
360	54	0	79	349

Table 11

Refrigerant	Suction Pressure (psig)	Discharge Pressure (psig)	Motor Winding Temperature (°C)
R-22	93	415	130
R-407C	86	470	130

Compressor Test Wear Rating Evaluation is determined using the following criteria to score the components of the compressor following the test and dismantling the compressor for examination.

Rating	Description
0	No change, no marking or visible signs of wear
1	Low wear, evidence of light polishing over a small area
2	Moderate wear, light scratching or polishing. The surface treatment may be worn away in a localised area
3	Marked wear, the surface may be worn away in an area. Wear may be observed as light scratching. This will be felt as a slight roughness if a point is drawn across the surface.
4	High wear, the surface will show clear scratches in the wear zone. The wear will be apparent and a point drawn across will feel rough, possibly with steps.
5	Very high wear, extensive wear in the loaded area. A wear step will be felt between the surface and the virgin metal. Fracture and seizure included

Compressor Test Results

A total wear figure is obtained by analysing the wear at 15 separate points. However, the wear figures at the outer surface of the compression member 20 and the vane tip 24 as shown in Figure 1 are the crucial figures to consider in determining whether the wear taking place in th compressor is considered to be acceptable or

not. In terms of the Compressor Test Wear Rating Evaluation, an average of 3 on those two locations is considered to be on the boundary of acceptability.

The results are shown in Table 12.

Table 12

Sample No	Refrigerant	Wear Scores		
		Vane Tip 24	Comp M 20	Total
Sample 9	R-407C	3	3	17.5
Sample 10	R-407C	2.5	4.5	31
Sample 11	R-407C	2.5	2.5	24
Sample 12	R-407C	1	2	14
Sample 14	R-407C	5	5	37
Sample 15	R-407C	2	3	28
Sample 16	R-22	3.5	4.5	40

As can be seen from these results, lubricant compositions according to the invention minimise the wear on the components of the compressor.

Claims

1. A lubricant composition for use in a rotary vane compressor has a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

2. The use in a rotary vane compressor of a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

3. A method of lubricating a rotary vane compressor comprises utilising a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

4. A fixed-vane rotary compressor charged with a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

5. A refrigeration system comprising a fixed-vane rotary compressor, said system being charged with a refrigerant comprising a chlorine-free, fluorine-containing heat transfer fluid and a lubricant composition having a base oil component that comprises an alkylbenzene as a major component thereof and a polyol ester as a minor component thereof.

6. A refrigeration system according to claim 5 in which the refrigerant is a hydrofluorocarbon and more preferably is selected from the group comprising difluoromethane (R-32), trifluoromethane (R-23), 1,1,2,2-tetrafluoroethane (R-134), 1,1,1,2-tetrafluoroethane (R-134a), 1,1,1-trifluoroethane (R-143a), 1,1-difluoroethane (R-152a) pentafluoroethane (R-125) and hexafluoroethane (R-116) and mixtures of two or more thereof.

7. A refrigeration system according to claim 6 in which the refrigerant is selected from the group comprising R-32, R-116, R125, R134a, R-143a and mixtures thereof.

8. In the lubricant composition as defined in any one of the preceding claims, the base oil component thereof comprises at least 55% by weight of alkylbenzene and at most 45% by weight of a polyol ester; more preferably between 55% and 75% by weight of alkylbenzene and between 45% and 25% by weight of polyol ester.

9. In the lubricant composition as defined in any one of the preceding claims, the base oil component thereof consists essentially of alkylbenzene and polyol ester.

Applicant's Reference 01FP0016

Figure 1

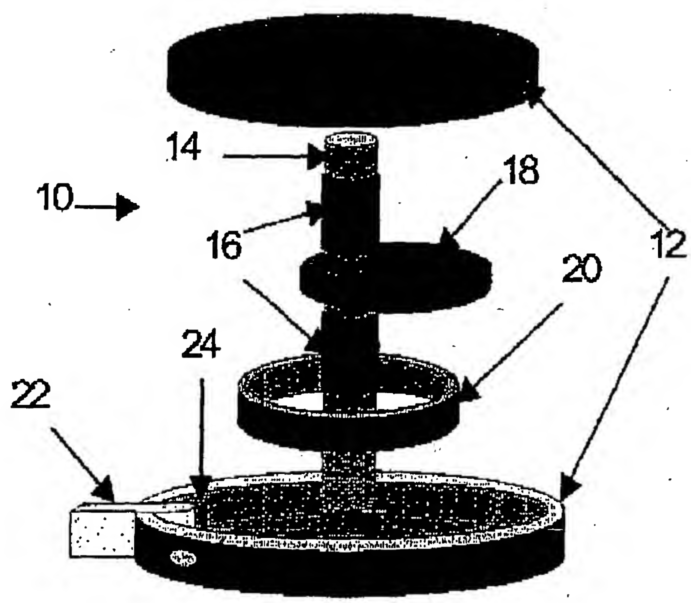


Figure 2